

<b>BROOKHAVEN NATIONAL LABORATORY</b> Safety & Health Services Division  <b>INDUSTRIAL HYGIENE GROUP</b> Standard Operating Procedure: Field Procedure	NUMBER <b>IH97300</b>
	REVISION <b>Final Rev 0</b>
SUBJECT: INSTRUMENT OPERATION: <b>Ozone Generation Using the Total Zone TZ-2® in IAQ Remediation</b>	DATE <b>09-07-04</b>
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### **1.0 Purpose/Scope**

This procedure provides a standardized method for the operation of the *International Ozone Total Zone® TZ-2* ozone generator. It should be used in conjunction with the SBMS Subject Area Indoor air quality and IH SOP IH97200 *Indoor Air Quality Investigations*.

*International Ozone Total Zone ozone generator TZ-2* model uses corona discharge technology known as "SP-ARC " (Silicate Polarized Arc) to produce 3000 mg per hour of ozone with an output of 100 cfm. The system has a 12 hour timer and is thus capable of delivering 120,000 cubic feet exchange of room air in one timer setting. This capacity far exceeds the needs of the average room, so care must be used in setting the timer appropriately to the size of the room. Because ozone is hazardous by inhalation, this equipment is only to be used in un-occupied areas under the direction of a SHSD professional Industrial Hygienist.

### **2.0 Responsibilities**

- 2.1 Use of the TZ-2 Ozone generator is limited to persons who act under the direction of a competent hazard assessment person and have demonstrated the competency to satisfactorily use the equipment, as evidenced by experience and training, to the

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satisfaction of the Industrial Hygiene Manager or IAQ Program Administrator and met the qualification criteria set in Section 7.

- 2.2 Personnel that perform remediation with this instrument are responsible to follow all steps in this procedure.

### 3.0 **Definitions**

**Ozone:** a molecule composed of three atoms of oxygen. Two atoms of oxygen form the basic oxygen molecule. The third oxygen atom can detach from the ozone molecule, and attach to molecules of other substances, thereby altering their chemical composition. It is this ability to react with other substances that forms the basis of purification by ozone treatment.

### 4.0 **Prerequisites**

#### 4.1 **Training prior to using this ozone generator:**

- 4.1.1 Demonstration of proper operation of the instrument to the satisfaction of the Industrial Hygiene Manager or IAQ Program Administrator. See Section 7 for qualification requirements.
- 4.1.2 Other appropriate training for the area to be entered (check with ESH coordinator or FS Representative for the facility).

#### 4.2 **Area Access:**

- 4.2.1 Contact the appropriate Facility Support Representative or Technician to obtain approval to enter radiological areas.
- 4.2.2 Verify with the appropriate Facility Support Representative or Technician if a Work Permit or Radiological Work Permit is needed or is in effect. If so, review and sign the permit.
- 4.2.3 Use appropriate PPE for area.

#### 4.3 **Case-by-case approval:**

- 4.3.1 The TZ-2 is capable of generating ozone at many times the PEL and TLV. It is possible to create concentrations temporarily up to 50-75 ppm in the typical office size room. Thus, it can only be used after ALL of the following conditions have been met:
  - 4.3.1.1 Users is fully trained and qualified in writing on this procedure and is

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knowledgeable of the hazards of ozone

- 4.3.1.2 The application of ozone is approved on a case-by-case basis by the SHSD Industrial Hygiene Manager or IAQ Program Administrator.
- 4.3.1.3 A Work Permit is completed.
- 4.3.1.4 The area is appropriately marked and guarded to prevent unauthorized entry during operation of the equipment. Because of the high concentration ozone generating capacity of the TZ-2, it can only be operated in an un-occupied area.
- 4.3.1.5 Monitoring equipment is in place to verify safe re-entry into the area. The TZ-2 user will verify safe atmospheric levels from a safe distance before actually entering and allowing re-occupancy any area that has had ozone generation.

## 5.0 Precautions

**5.1 Hazard Determination:** Because concentrations of ozone that do not exceed occupational exposure limits have little remediation effect on indoor air odors and their sources, the meter is intentionally operated in a manner that would produce ozone levels exceeding OELs if worker/occupants were present. Thus, observe the following warning from EPA:

**Observe the following EPA Warning:** High concentrations of ozone in air, **when people are not present**, are sometimes used to help decontaminate an unoccupied space from certain chemical or biological contaminants or odors (e.g., fire restoration). However, little is known about the chemical by-products left behind by these processes. While high concentrations of ozone in air may sometimes be appropriate in these circumstances, **conditions should be sufficiently controlled to insure that no person or pet becomes exposed.**

Ozone can adversely affect indoor plants, and damage materials such as rubber, electrical wire coatings, and fabrics and art work containing susceptible dyes and pigments (U.S. EPA, 1996a).

- 5.1.1 **This ozone generator is capable of generating very dangerous levels of ozone regarding worker health.** Relatively low amounts of ozone can cause chest pain, coughing, shortness of breath, and, throat irritation. Ozone may also worsen chronic respiratory diseases such as asthma and compromise the ability of the body to fight respiratory infections. People vary widely in their susceptibility to

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ozone. Recovery from the harmful effects can occur following short-term exposure to low levels of ozone, but health effects may become more damaging and recovery less certain at higher levels or from longer exposures (US EPA). The Occupational Safety and Health Administration (OSHA) requires that workers not be exposed to an average concentration of more than 0.10 ppm for 8 hours. The ACGIH TLV is activity based, with standards of 0.1 ppm light work, which is comparable to setting up this equipment. The proximity of a person to the ozone generating device will affect exposure. The concentration is highest at the point where the ozone exits from the device, and decreases away from the unit. The TZ-2 is capable of generating many times the PEL and TLV, thus it can only be used by fully trained workers after approval on a case-by-case basis by the SHSD IH Group Manager.

- 5.1.2 Ozone can damage electrical insulation and computer components. Advise occupants to remove sensitive equipment.
- 5.1.3 By its very nature, the TZ-2 ozone generator may be used in areas where low level IAQ hazards exist or are suspected to be present. Exposures to ambient level IAQ irritants may cause temporary or permanent health impairments in sensitive individuals.
- 5.1.4 The operation of this ozone generator does not expose the operator to physical or radiological hazards. The ozone generator design does not cause significant ergonomic concerns in routine use.
- 5.1.5 The ozone generator does not generate Hazardous Waste and its temporary use has been evaluated by EWMSD to not require air permitting.

## **5.2 Personal Protective Equipment:**

- 5.2.1 In areas where ozone generation is occurring, it is anticipated that levels will temporarily exceed the *Occupational Exposure Limit (OEL)*. Entry into these areas during meter operation and for 2 hours afterwards is not authorized even if respiratory protection is worn. After two hours, due to the natural reverting of ozone back to diatomic oxygen, the ozone levels are not expected to exceed the *Occupational Exposure Limit (OEL)*, but verification by instrumentation or direct reading detection is required prior to entry.
- 5.2.2 In an emergency situation, if entry into an ozonated area is required earlier than 2 hours after treatment, after approval by the IH Manager, appropriate respiratory protection must be worn, i.e. the IH Groups air line respirator or equivalent.
- 5.2.3 Additional PPE: Other appropriate PPE may be needed for the area being

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entered. Check with your ES&H Coordinator or Facility Support Representative.

## **6.0 Procedure**

### **6.1 Equipment:**

- Ozone generator TZ-2.
- Ozone Detection equipment (either the Dasibi meter, indicator tubes or passive detection badges.
- Area marking tape and sign(s).

**6.2 Theory of Operation:** The generator produces ozone based on electric corona arc, in the same manner as lightning. The actual concentration of ozone produced by an ozone generator depends on many factors. Concentrations will be higher if:

- The device is placed in a small space rather than a large space,
- Interior doors are closed rather than open and,
- The room has fewer rather than more materials and furnishings that adsorb or react with ozone and,
- There is less rather than more outdoor air ventilation.

### **6.3 Securing and Posting the Area: Prior to starting the generator:**

- 6.3.1 **Notify the Building Manager, ESH Coordinator, SHSD Work Planning Coordinator, IH Manager or IAQ Program Administrator, and room occupants.**
- 6.3.2 Have sensitive equipment removed.
- 6.3.3 **Post warning signs at all entrances. See Attachment 9.2 for sign wording.**
- 6.3.4 **Place warning “Caution” tape across all doorways and passageways**
- 6.3.5 **Secure doors with locks.**

### **6.4 Calculating the appropriate operating time:**

The TZ-2 fan output is 100 cfm

Calculate the volume of air to be treated (i.e the room size)

L x W x H, example: 12' x 12' x 8' = 1152 cu ft (a typical office size)

$1152 \text{ cu ft} / 100 \text{ cfm} = 11.5 \text{ minutes}$

Thus after 11.5 minutes, all the air in the room (assuming even mixing, which is not true) will have passed through the unit.

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For this size room, experience indicates about 1 hour should be used for odor control such as cigarette smoke. More time is needed to eliminate mold and mildew odors. Multiple applications of the ozone generator may be needed for permanent control.

#### 6.5 Calculating the resulting ozone concentration:

- The TZ-2 generates ozone at the rate of 3000 mg/hr.
- The molecular weight of ozone is 48.

On a “per hour of operation” basis for a room 12 ft x 12 ft x 8 ft = 1152 cu ft = 32621 Liters = 32.6 m<sup>3</sup>

$$[(3000 \text{ mg}^3) \div \text{room size (in m}^3\text{)} \times 48] / 24.45 = \text{ppm in room}$$

$$[(3000 \div 32.6) \times 48] / 24.45 = 180 \text{ ppm}$$

During the hour some of the ozone will decay (within 20 minutes), thus the 180 ppm calculation would be higher than the measured concentration would be.

#### 6.6 Properly locating the generator and setting up the room:

- 6.6.1 Set the unit by an wall unit air condition return if possible. If no wall unit AC, then set the unit in the middle of the room. If there is a wall A/C unit, allow it to run in the recirculating mode. This will help mix the air and cooler temperature and lower humidity allow the ozone to work better.
- 6.6.2 Mop up any wet areas before starting.
- 6.6.3 Close doors and windows.
- 6.6.4 Do not allow ozone to enter a whole building HVAC system. Seal “returns” into a whole building HVAC unit.
- 6.6.5 Avoid diluting ozone with untreated air and do not “pressurize” the room. Shut off and seal the supply coming from a whole building HVAC unit. If not possible, open a window an adequate amount to allow all the supply volume to escape the room and be vented outdoors. Do not allow the ozone to leak into occupied areas.
- 6.6.6 Set the unit at least 6 inches from walls and any structure that could block the air intake (back of unit). Do not set the unit to blow directly on any objects.
- 6.6.7 **Do not use in flammable or explosive atmosphere.**
- 6.6.8 Remove plants and food items.

#### 6.7 Final pre-start check: Prior to operation:

- Ensure that ozone will not enter occupied portions of the building by infiltration

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- of HVAC unit or opening in walls.
- Ensure that all pathways for persons to enter the room are locked, posted, and barrier tape is up.
- Ensure that the pathway for you and all others to leave the area is clear and that no other actions are needed in the area.
- Evacuate everyone from the room.

6.8 **Turning Power On:** The meter is very simple to operate. Turn the timer knob to the desired time (in hours). The generator immediately starts producing ozone. Ozone is directed out the front of the unit. **Leave the area immediately.**



6.9 **Warm-up:** A warm-up is not required for this ozone generator. High levels of ozone are produced immediately. Leave the area immediately.

6.10 **Operator Position:**

**No one, under any circumstances, is allowed to remain in the area after starting the TZ-2.**

6.11 **Re-occupying the room.**

**No one is allowed to re-enter the room before two hours have elapsed beyond the timer setting, unless direct reading measurements indicate the OEL (0.1 ppm Ceiling) is not exceeded.**

- 6.11.1 Prior to entering verify by sight and sound that the generator is off and the timer has ended.
- 6.11.2 Use a direct reading instrument measurements or indicator tube/badge to indicate the OEL is not exceeded.
- 6.11.3 Enter the room and verify that status of the room, and disassemble the generator for removal.

6.12 **Recording readings:**

- Use the BNL Direct Reading Sampling Instrument Form to record post-ozonation readings (see the IH web page for the most recent version).
- Return ozone generator and original sampling form to the SHSD IH Laboratory daily or at the end of each project as agreed to by the IH Laboratory Technician.
- Send a copy of any hazard evaluation report written on the survey to the IH

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Laboratory.

## **7.0 Implementation and Training**

Prior to using this ozone generator, the operator:

- 7.1 Demonstrates proper operation of this instrument to the satisfaction of the SHSD IH Manager or IAQ Program Administrator.
- 7.2 Completes other appropriate training for the area to be entered (check with ESH coordinator or FS representative for the facility).
- 7.3 Completes OT&Q Training and a medical surveillance required for any PPE used on the job or for other hazards encountered in the work area.
- 7.4 Qualification on this JPM is required on a 3 year basis, providing the professional uses the equipment several times per year.
- 7.5 Personnel are to document their training using the Attachment 9.2 with its *Job Performance Measure Completion Certificate* for this ozone generator.

## **8.0 References**

8.1 TZ-2 Ozone Generator *Owners Guide*

8.2 EPA Indoor Air Publications: "*Ozone Generators that are Sold as Air Cleaners: An Assessment of the Effectiveness and Health Consequences.*" 07/26/04,  
[www.epa.gov/iaq/pubs/ozonegen.html](http://www.epa.gov/iaq/pubs/ozonegen.html).

8.3 BNL SBMS Subject Area *Indoor Air Quality*

## **9.0 Attachments**

9.1 Sign for posting ozone remediation areas

9.2 Ozone Generator Operation Qualification *Job Performance Measure* form.

## **10.0 Documentation**



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## **Attachment 9.1**

### **Sign for Posting Ozone Remediation Areas**

**(see next page)**

CAUTION

DO NOT ENTER

ROOM IS UNDERGOING  
TREATMENT FOR MOLD

VERY HIGH LEVELS OF OZONE MAY  
BE PRESENT THAT COULD CAUSE  
SERIOUS INJURY IF INHALED

For information on entry, CONTACT\_\_\_\_\_

**Operation of the TZ-2 Ozone Generator for IAQ Remediation**  
**Job Performance Measure (JPM) Completion Certificate**

Candidate's Name	Life Number:
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**Practical Skill Evaluation: Demonstration of Evaluation Methodology by Oral Exam**

Criteria	Qualifying Performance Standard	Unsat.	Recov.	Satisf.
1. Hazard Analysis	Understands the need to perform a hazard analysis of the area and potential exposure to the self as sampler and workers in the area.			
2. Personal Protective Equipment	Understands the need to be aware of the ozone airborne levels, airborne levels of other contaminants, radiological hazards, noise hazards, etc. Knows how to determine the need for PPE.			
3. Sampling Equipment	Knows where equipment needed for the procedure is located and how to properly sign it out.			
6. Operating ozone generators	Knows the ozone generators safety envelope.			
7. Documentation	Demonstrates correctly filling out IH monitoring forms.			

**Ozone generator Operation - Practical Skill Evaluation: Demonstration of Methodology**

Criteria	Qualifying Performance Standard	Unsat.	Recov.	Satisf.
1. Area Safety & Posting	Demonstrates the method to correctly prepare the area for remediation			
2. Turning the Ozone generator On and Off	Demonstrates correctly activating the ozone generator and turning it on			
3. Recording data	Demonstrates correctly record data from the ozone detection equipment			

I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:
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I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date:
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